



May 9, 2019

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Approved 5/14/2019

High priority for SI

*Cathy Amoroso*

**Subject: Final Preliminary Assessment Report  
Patterson Street Solvent Plume  
EPA Identification No. NCN000404887  
EPA Contract No. EP-S4-14-03  
TDD No. TT-05-041**

Dear Ms. Amoroso:

The Tetra Tech, Inc. Superfund Technical Assessment and Response Team (START) is submitting this final preliminary assessment report regarding the Patterson Street Solvent Plume site in Greensboro, Guilford County, North Carolina. This final report incorporates all comments received to date. Also included with this submittal are figures (Appendix A) and the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) Eligibility Form (Appendix B). Supporting reference materials have been uploaded to the EPA Region 4 Superfund Site Assessment Share Point website.

Please contact me at (678) 775-3101 if you have any questions or comments regarding this submittal.

Sincerely,

A handwritten signature in black ink that reads 'Quinn Kelley'.

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A handwritten signature in black ink that reads 'Andrew F. Johnson'.

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Enclosure

cc: Katrina Jones, EPA Project Officer  
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**FINAL  
PRELIMINARY ASSESSMENT REPORT  
PATTERSON STREET SOLVENT PLUME  
GREENSBORO, GUILFORD COUNTY, NORTH CAROLINA**

**U.S. EPA ID NO. NCN000404887**

**Revision 0**

**Prepared for**

**U.S. ENVIRONMENTAL PROTECTION AGENCY  
Region 4  
Atlanta, Georgia 30303**

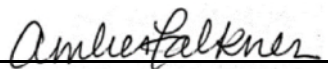


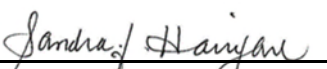
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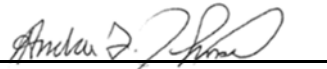
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## 1.0 INTRODUCTION

The U.S. Environmental Protection Agency (EPA), under authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA), tasked the Tetra Tech, Inc. (Tetra Tech) Superfund Technical Assessment and Response Team (START) with conducting a preliminary assessment (PA) of the Patterson Street Solvent Plume (Patterson Street) site in Greensboro, Guilford County, North Carolina (EPA Identification Number [No.] NCN000404887). The PA was completed under Contract No. EP-S4-14-03, Technical Direction Document (TDD) No. TT-05-041.

The purposes of a PA are to review existing information about a site and its environs to assess the threats, if any, posed to public health, welfare, or the environment, and to determine whether further investigation under CERCLA/SARA is warranted. The scope of the PA includes reviewing information available from federal, state, and local agencies. By use of these sources of existing information, the site is then evaluated according to EPA Hazard Ranking System (HRS) criteria to assess the relative threat associated with actual or potential releases of hazardous substances at the site. EPA adopted the HRS to help set priorities for further evaluation and eventual remedial action at hazardous waste sites. The HRS is the primary method of determining a site's eligibility for placement on the National Priorities List (NPL). The NPL identifies sites where the EPA may conduct remedial response actions. This report summarizes findings of the PA of the Patterson Street site.

The PA report was written in conformance to guidance from EPA publications *Guidance for Performing Preliminary Assessments under CERCLA* (Ref. 1), *Guidance for Performing Site Inspections under CERCLA* (Ref. 2), and "Hazardous Ranking System Final Rule" (Ref. 3).

The remainder of this PA report is organized as follows:

- Section 2.0 discusses the site background, including the site location and description; operational and regulatory histories; and previous investigations for facilities evaluated as part of this PA.
- Section 3.0 describes the groundwater migration, surface water migration, soil exposure and subsurface intrusion, and air migration pathways, and lists data gaps.
- Section 4.0 summarizes and provides conclusions for the PA.
- Section 5.0 lists references used to support the PA report.
- Figures are in Appendix A and the CERCLA Eligibility Form is in Appendix B.

## 2.0 SITE BACKGROUND

This section discusses the site background, including the site location and description, operational and regulatory histories, previous investigations, and source areas and waste characteristics.

### 2.1 SITE LOCATION AND DESCRIPTION

The Patterson Street site is defined as a contaminated groundwater plume with no definitive source, located in a residential area south of an industrial corridor. The study area encompasses about 349.1 acres of land surrounding the intersection of Patterson Street and South Holden Road in Greensboro, Guilford County, North Carolina. The study area extends from industrial businesses on the north side of Patterson Street between Merritt Drive and Binford Street to a small residential neighborhood bordered by West Florida Street to the south, South Holden Road to the West, and Swan Street to the east directly south of Patterson Street (see Figure 2 in Appendix A). Several industrial facilities are within the study area, including Ashland Chemical, Inc. (Ashland Chemical), Dow Corning Corporation (Dow Corning), Ecoflo, Inc. (Ecoflo), and the North Carolina Department of Transportation Site # 61 (NC DOT), among others (Ref. 14, p. 1) (see Figure 2 in Appendix A). The area hosts major suppliers of blended bulk chemicals to furniture, textile, and other manufacturing businesses (Ref. 5, pp. 2, 3). Releases to the environment of chlorinated volatile organic compounds (VOC) are known or suspected to have occurred at four North Carolina DEQ Inactive Hazardous Site Branch (IHSB) sites and three Resource Conservation and Recovery Act (RCRA) sites along the Patterson Street industrial corridor (Ref. 4, p. 1). Geographic coordinates for the Patterson Street site, as measured from the intersection of Patterson Street and South Holden Road, are latitude 36.057192 degrees north and longitude 79.841981 degrees west (see Figure 1 in Appendix A).

The Patterson Street study area is bordered to the north by a Norfolk-Southern railway, to the south by residential properties, and to the east and west by commercial and residential properties (Refs. 5, p. 3; 6, p. 13; 7). The EPA is evaluating groundwater and air contamination that may be linked to industrial facilities along the Patterson Street corridor; the primary focus of EPA's evaluation is the residential areas in proximity to known groundwater contamination. Due to the large number of potential sources and suspected comingling of a groundwater contaminant plume, for the purposes of the PA, this Site is considered a groundwater plume with no definitive source.

## **2.2 FACILITIES EVALUATED DURING THIS PRELIMINARY ASSESSMENT**

This section discusses facilities at the site, summarizing their operational and regulatory histories, operation dates, permits, notices of violation, and cleanup agreements. It also recounts previous investigations and summarizes disposal operations at those facilities.

### **2.2.1 Ashland Chemical**

The following subsections describe the operational and regulatory history for Ashland Chemical, as well as the previous investigations conducted at the facility.

#### ***2.2.1.1 Operational and Regulatory History for Ashland Chemical***

Ashland Chemical was constructed in 1954 by F.H. Ross Company as a storage facility for laundry supplies and industrial solvents (Ref. 8, p. 2-1). F. H. Ross Company operated on the property until 1968, when it was transferred to Ashland Chemical for distribution of bulk industrial chemicals and solvents (Ref. 8, p. 2-1). The Ashland Chemical property included a 21,000-square-foot warehouse with an accompanying office building, railroad spur, car off-loading area, 20 aboveground storage tanks (AST), and seven underground storage tanks (UST) (Ref. 8, pp. 2-1, 22). Chemicals for production were stored in ASTs and USTs and distributed from loading areas and a former railroad spur (Ref. 8, p. 2-1). Most of the storage tanks were in the northern portion of the facility, north of the warehouse and railroad spur. Directly east of the warehouse were the hazardous waste storage areas, two USTs, and the corrosives transfer pad (Ref. 8, pp. 22, 23). ASTs and USTs were used for storage of bulk dry and liquid products shipped to the facility (Refs. 8, p. 2-1). USTs of various capacities contained a variety of chemicals, including HiSol 15, HiSol 99, methanol, gasoline, diesel, toluene, and total xylenes (Ref. 9, p. 1). The property was transferred in 2003 and is currently owned by Koury Corporation and is operated as a hotel maintenance and storage facility (Ref. 8, p. 2-1). Deed restrictions and environmental covenants were included in the sale of the property to Koury Corporation (Refs. 8, p. 2-1; 10, p. 2).

On April 11, 1983, a permit application was submitted to the North Carolina Department of Environment and Natural Resources (NCDENR), Hazardous Waste Section, requesting permission to operate a hazardous waste storage pad facility (Ref. 10, p. 2). The permit was issued on July 5, 1984, allowing Ashland Chemical to store hazardous waste in a container storage unit with a maximum of 100 55-gallon containers (Ref. 10, p. 2). Since initiation of environmental investigations by T.M. Gates in 1988,

Ashland Chemical has prepared and submitted to NCDENR hazardous waste annual reports that identify Ashland Chemical as a small quantity generator with the assigned EPA ID Number NCD024599011 (Refs. 5, p. 4; 10).

On April 25, 1988, a notice of noncompliance (NON) was issued to Ashland Chemical for violations of North Carolina's Title 15A *North Carolina Administrative Code* Subchapter 2L (NCAC 2L) Groundwater Quality Standards (GWQS) at the Site. In response, on May 24, 1988, Ashland Chemical submitted an action plan for remediation that included an investigation of soil and groundwater contamination beyond the Ashland Chemical property (Ref. 5, p. 1). On February 26, 1992, a Special Order by Consent (SOC) between Ashland Chemical and North Carolina's Department of Environmental Management (NCDEM) required Ashland Chemical to complete the work recommended in the 1988 Remedial Action Plan (Ref. 5, p. 2).

In 1992, Ashland Chemical contracted Spade Corp for storage tank removal and Sirrine Environmental Consultants for backfilling and subsequent soil sampling for closure documentation. Seven USTs of various capacities containing fuels, xylenes, and toluene were removed from the northern portion of the property (Ref. 9, p. 1, Table 1, Figure 1). Confirmation soil sampling following removal indicated that releases from tanks had occurred, prompting multiple investigations (see Section 2.3 of this report) (Ref. 9, pp. 1, 2, 5, 6, Table 1). Soil samples collected at Ashland during contained the following at indicated maximum concentrations: carbon tetrachloride, 240,000 micrograms per kilogram ( $\mu\text{g}/\text{kg}$ ); 1,1-DCE, 140  $\mu\text{g}/\text{kg}$ ; PCE, 3,100,000  $\mu\text{g}/\text{kg}$ ; TCE, 36,000  $\mu\text{g}/\text{kg}$ ; toluene, 900,000  $\mu\text{g}/\text{kg}$ ; xylenes, 750,000  $\mu\text{g}/\text{kg}$ ; and vinyl chloride, 29  $\mu\text{g}/\text{kg}$  (Ref. 5, Table 3).

In 2006, Ashland Chemical installed an advanced remediation technology (ART) system consisting of six monitoring wells that apply air sparging, soil vapor extraction, and air stripping technologies (Ref. 10, p. 3). Collected vapors are pumped through a carbon filter before release to the atmosphere (Ref. 10, p. 3). The ART system was shut down on May 23, 2013, to evaluate its effectiveness. In 2018, the ART system was removed (Ref. 10, p. 3).

Wastes generated at Ashland Chemical included chlorinated hydrocarbon solvents, such as: 1,2-dichloroethane (DCA), 1,1-dichloroethene (DCE), tetrachloroethylene (PCE), trichloroethylene (TCE), and benzene (Refs. 4, p. 3; 11, pp. 8, 9; 18, p. 7). Before 2003, Ashland Chemical had operated as a large quantity generator of hazardous waste. Since 2003, Ashland Chemical has operated as a conditionally exempt, small quantity generator based on generation of hazardous waste from purge water and the

remediation system (Ref. 10, p. 3). Seven USTs were removed in 1992 due to releases of chemicals from the storage tanks (Ref. 9, pp. 2, 6). Elevated levels of chlorinated solvents were consistent in two locations on the property: (1) soils in the northwestern corner, north of an existing warehouse where the tank farm was formerly located; and (2) soils along the former railroad spur, north of the Johnston properties where chemicals had been loaded for distribution (Ref. 8, pp. 3-4, 22).

#### ***2.2.1.2 Previous Investigations at Ashland Chemical***

In February 1988, T.M. Gates collected soil samples from the vadose zone during UST removal at Ashland Chemical. Analytical results from those soil samples indicated the presence of carbon tetrachloride, 1,1-DCE, PCE, 1,1,1-trichloroethane (TCA), TCE, toluene, vinyl chloride, and xylenes above the method detection limit (Ref. 5, Table 3). The highest levels of VOCs were observed from 3 to 5 feet below ground surface (bgs) (Ref. 5, Table 3).

In April 1992, Rust Environment and Infrastructure (Rust) (formerly known as Sirrine Environmental Consultants) collected 11 groundwater samples at Ashland Chemical (Ref. 5, p. 5). Analytical results from those groundwater samples indicated the presence of chlorobenzene, 1,2-DCE, methylene chloride, PCE, toluene, and xylenes above the detection limit (Ref. 5, pp. 5, 6, Table 4). PCE appeared to be the most widespread VOC observed in the groundwater (Ref. 5, p. 5).

In May 1993, Rust collected soil and groundwater samples during a hydrogeologic investigation at the Ashland facility (Ref. 5, p. 2). Analytical results from groundwater samples indicated presence of benzene, carbon tetrachloride, methylene chloride, PCE, toluene, 1,1,1-trichloroethane (TCA), TCE, and xylenes (Ref. 5, Table 5). The highest concentrations of volatile organic compounds (VOC) were in monitoring wells MW-5, MW-6, and MW-10, where the former USTs had been located (Ref. 5, p. 16, Figure 2, Figure 3). Analytical results from soil sampling indicated the presence of carbon tetrachloride, 1,1-DCE, PCE, 1,1,1-TCA, TCE, toluene, and xylenes (Ref. 5, Table 3, Table 4). Soils with the highest concentrations of VOCs were in the northern portion of the Ashland property where ASTs and USTs had been located (Ref. 5, Figure 2). Rust concluded that additional on-site remediation efforts should occur to reduce on-site groundwater contamination (Ref. 5, p. 18).

In August 2010, Arcadis conducted soil gas sampling as a refinement to the existing remedial strategy at Ashland Chemical (Ref. 6, pp. 3, 4). Analytical results from soil gas samples indicated the presence of 1,4-dichlorobenzene, cis-1,2-DCE, PCE, TCE, and total petroleum hydrocarbons (TPH) (Ref. 6, pp. 4, 5).



A habitat assessment occurred to identify riparian flora and fauna around the unnamed tributary to link human health and ecological effects to the site (Ref. 6, p. 9). Arcadis recommended additional investigations to assess horizontal and vertical extents of VOC impacts on soil and groundwater, addition of five monitoring well pairs for further assessment, and determination whether any accelerated remediation technology (ART) systems would be necessary for assessment of the site (Ref. 6, pp. 6, 7, 8).

In 2016, Arcadis, on behalf of Ashland LLC, conducted annual groundwater and semi-annual surface water sampling at the former Ashland Chemical facility (Ref. 57, p. 1). All accessible monitoring wells were sampled (Ref. 57, p. 1). Analytical results from monitoring well samples indicated the presence of 1,1-DCA, 1,1-DCE, cis-1,2-DCE, TCE, PCE, and 1,4-dioxane at concentrations exceeding NCAC 2L GWQSs (Ref. 57, Table 2). Analytical results from surface water samples indicated presence of PCE greater than NCAC 2B surface water quality standards (Ref. 57, p. 3, Table 3). Low concentrations of 1,1-DCE, cis-1,2-DCE, and TCE also were detected. VOCs are well defined within the current monitoring network but continue to occur over the migration pathway of the Site (soil to groundwater to subsurface vapor intrusion) (Ref. 57, p. 4). The final corrective measures were outlined in a corrective measure study (CMS) report dated October 2014 (Ref. 57, p. 4).

In June 2017, Arcadis, on behalf of Ashland, conducted a groundwater monitoring assessment to better understand the groundwater flow characteristics in deeper portions of the aquifer downgradient of the former Ashland Chemical site (Ref. 59, p. 1). A series of monitoring wells were sampled between 3.25 and 8.25 feet below ground surface (bgs). Results indicated the presence of 1,1-DCE, cis-1,2-DCE, PCE, and TCE (Ref. 59, Figure 3-3). Arcadis plans to conduct further studies on a quarterly basis (Ref. 59, p. 2).

## **2.2.2 Dow Corning**

The following subsections describe the operational and regulatory history for Dow Corning, as well as the previous investigations conducted at the facility.

### ***2.2.2.1 Regulatory and Operational History for Dow Corning***

Dow Corning began operations in 1954 as a packaging plant under the company name of Dow Silicones Corporation. The company changed its name in 1967 to Dow Corning Corporation after broadening its services from silicone production to packaging and large-quantity manufacturing of silicone anti-foams,

industrial lubricants, eye-glass cleaner, electro-metallurgicals, sealants, coatings, primers, synthetic rubber, adhesives, and other non-silicone products (Refs. 12, p. 3; 13, p. 1; 14, p. 1; 15, p. 6; 16, p. 3).

In 2014, Dow Corning employed approximately 140 employees (Ref. 13, pp. 1, 2). The facility includes six separate buildings on the north side of Patterson Street and undeveloped land on the south side of Patterson Street (Ref. 16, Figure 2-1). Wastes primarily were stored in tank farms near Buildings 1 and 3 or in USTs around the facility (Ref. 16, Figure 5-2). Groundwater has been impacted by intermittent releases of solvents or solvent mixtures to the soils in the immediate vicinity of a wastewater overflow accumulation tank adjacent to Building 1 and the oil-water separator near Building 3. Materials were either off-loaded in the loading area between Buildings 2 and 3 or in the truck dock north of Building 5 (Ref. 15, Figure 5-2). Chemicals also were stored in USTs around the facility.

Dow Corning obtained an air permit starting in June 1980 (Ref. 29, p. 2). Hazardous wastes and materials associated with Dow Corning include: aliphatic hydrocarbons (such as ethene), adhesives, methylene chloride, PCE, 1,1,1-TCA, TCE, and total xylenes (Refs. 13, p. 2; 14, p. 3; 17, p. 2; 18, p. 13, 14; 19, p. 3). Elevated levels of chlorinated solvents are present in soil in the hazardous waste management unit (HWMU) area, USTs near Building 3, and the soil surrounding the wastewater overflow accumulation tank and its associated piping (soil contaminated by releases of liquids stored within the tank) (Ref. 22, p. 12). DNAPLs were not detected as a mobile phase in soil and at the base of the upper aquifer system at the Site (Ref. 22, pp. 12, 21). If any migration of DNAPLs did occur, the migration would have been most likely limited to the upper eight feet of the area (Ref. 16, p. 21). Wells in the HWMU area indicated the DNAPLs have not reached a critical height or length needed for horizontal migration as a separate phase beneath the water table (Ref. 16, p. 31). Soil samples collected at the Dow Corning site contained the following compounds at indicated maximum concentrations: 1,1-DCA at 140 µg/kg; 1,1-DCE at 23 µg/kg; and 1,1,1-TCA at 48 µg/kg (Ref. 16, Table 2-3).

In November 1986, Dow Corning closed four USTs of various sizes around the property that contained fuel oil, toluene, total xylenes, and two ASTs containing water from production (Ref. 62, p. 6). The 1,000-gallon wastewater overflow accumulation tank, north of Building 1, had been identified as one of the primary sources of chlorinated solvent contamination at the facility (Refs. 14, p. 2; 16, p. 1; 17, p. 5; 19, p. 2). This tank stored wastewater used to clean out production kettles between products (Ref. 62, p. 56). Fifteen HWMUs had been present throughout the property, primarily in Buildings 1 and 3 (Ref. 62, Figure 7). Two tank farms were still present on the property: one on the north side of Building 3 and one on the north side of Building 1 (Ref. 16, Figure 5-2).

During the 1980s and 1990s, Dow Corning decommissioned and started the processes of removal of USTs and ASTs on the property, closing all floor drains associated with storage tanks in operation buildings, and investigating soil and groundwater releases from tanks (Refs. 15, p. 8, 20, 22). In 1985, a 1,000-gallon UST used for holding wash water from production kettles north of Building 1 was decommissioned and drain lines in operational buildings were closed off (Ref. 16, p. 4). The tank and approximately 42 cubic yards of soil were removed, replaced with clean fill, and capped with concrete on October 4 and 5, 1994 (Refs. 15, pp. 8, 9; 16, p. 7; 20, p. 1; 21, p. 1; 22, pp. 1, 6, 17). In 1986, four additional USTs containing fuel oil, xylenes, and toluene were removed (Ref. 23, p. 38). Groundwater monitoring has been ongoing since 1995, with documentation of releases of 1,1,1-TCA from the wash water holding tank (Refs. 13, p. 5; 14, p. 2; 17, p. 5; 19, p. 7; 22, p. 1; 24, p. 6).

In 1999, a vacuum enhanced pumping (VEP) system was installed to reduce concentrations of VOCs in the saturated zone and groundwater (Refs. 21, p. 1). The VEP operated for 18 months (Ref. 21, p. 1). In 2000, a phytoremediation plantation was installed downgradient of the manufacturing complex and Building 3 to take up groundwater during the year's wettest months and mitigate VOC migration (Refs. 15, p. 9; 26, p. 15). In May 2009, a dual-phase extraction system was installed in Building 3 aimed at removing contaminated vapor and groundwater. Extracted water was treated via air stripping and granular activated carbon (Refs. 26, p. 14). On August 31, 2011, an aggressive fluid and vapor recovery system (AFVR) was proposed. The system was designed to remove DNAPLs and chlorinated VOCs from groundwater under pulsing conditions (Ref. 27, p. 4). The remedial actions, in addition to natural attenuation processes over time, have resulted in declining concentrations of VOCs in groundwater (Ref. 26, Figure 6). In 2009, Building 2 underwent a substantial expansion to increase warehouse space. During construction, seven monitoring wells were abandoned (Ref. 48, p. 1). Remediation efforts continued from 2010 to 2018. During this time, no site deficiencies and no further recommendations were recorded in site inspections (Refs. 12, p. 7; 13, p. 5; 14, p. 8; 17, p. 5; 19, p. 8).

#### ***2.2.2.2 Previous Investigations at Dow Corning***

In March 1998, Shield Environmental Associates, Inc. (Shield) conducted a Phase III Site Investigation that included soil, groundwater, and soil gas sampling; monitoring well installation; and aquifer testing to evaluate the presence of DNAPLs at the base of the upper aquifer system at the site (Ref. 16, pp. 18 to 21). Analytical results from soil samples indicated the presence of 1,1,1-TCA, 1,1-DCA, and 1,1-DCE (Ref. 16, pp. 88, 87). Analytical results from groundwater samples collected from monitoring wells indicated the presence of 1,1-DCA, 1,2-DCA, 1,1,1-TCA, TCE, PCE, and vinyl chloride. The highest

concentrations of VOCs were detected in MW-6 (Ref. 16, pp. 67, 81 to 84). Analytical results from soil gas samples indicated the presence of 1,1-DCA, 1,1-DCE, and 1,1,1-TCA (Ref. 16, p. 88). Although the mechanism of release was unknown, the primary sources—the wastewater overflow tank and contents of an oil-water separator—had been removed from the site (Ref. 16, p. 34). Ongoing quarterly monitoring of existing wells was recommended, as well as an evaluation of aggressive remedial actions at the HWMU area (Ref. 16, p. 53).

In April 2010, Cardinal Resources conducted the semi-annual groundwater sampling event specified in a November 2001 Post-Closure Groundwater Sampling and Analysis Plan (Ref. 48, p. 1). This sampling event occurred after closure of some monitoring wells at the site due to plant construction in Building 2 (Refs. 26, pp. 26, 29; 48, p. 1). Analytical results indicated the presence of 1,1-DCA, 1,2-DCA, 1,2-dichloropropane, PCE, TCE, and vinyl chloride in groundwater (Ref. 48, p. 5).

In April 2014, URS Corporation (URS) performed the semi-annual groundwater sampling event specified in a November 2001 Post-Closure Groundwater Sampling and Analysis Plan and September 2011 Administrative Order (Ref. 51, p. 1-1). This sampling event included groundwater gauging and sampling and surface water sampling (Ref. 51, pp. 3-1, 3-2). Analytical results indicated the presence of 1,1-DCA, 1,2-DCA, 1,1-DCE, 1,2-DCE, PCE, 1,1,1-TCA, 1,1,2-TCA, TCE, and vinyl chloride in both groundwater and surface waters above the NC Tier 15A 2L standards (Ref. 51, Table 3, Table 4, Table 7).

In April 2015, URS conducted the semi-annual groundwater sampling event specified in a November 2001 Post-Closure Groundwater Sampling and Analysis Plan (Ref. 53, p. 6). This sampling event included groundwater gauging and sampling, and surface water sampling (Ref. 53, pp. 11, 12). Analytical results indicated the presence of 1,1-DCA, 1,2-DCA, cis-1,2-DCE, 1,1-DCE, 1,2-dichloropropane, 1,1,1-TCA, 1,1,2-TCA, PCE, TCE, and vinyl chloride in groundwater samples at concentrations above NCAC 2L GWQSSs, as well as TCE and vinyl chloride in surface water samples above NC 2B water quality standards (Ref. 53, pp. 22, 24, 28).

### **2.2.3 Ecoflo**

The following subsections describe the operational and regulatory history for Ecoflo, as well as the previous investigations conducted at the facility.

### ***2.2.3.1 Regulatory and Operational History for Ecoflo***

Ecoflo began operations on March 5, 2012, as a comprehensive waste management and industrial services company that performed hazardous waste treatment, storage, and disposal activities, and operated its own truck fleet for local and long-distance hazardous waste deliveries (Refs. 31, p. 1; 32, p. 7). The Ecoflo property hosted a 50,000-square foot warehouse (Ref. 33, Figure 1). No subsurface injections, landfills, or incinerators are on the site (Ref. 23, p. 11).

In 1984, a permit application was submitted to the NCDENR Hazardous Waste Section requesting permission to operate a hazardous waste storage pad facility. The permit was issued in July 1985, allowing Ecoflo to store 95,837 gallons of containerized waste and 35,000 gallons of bulk waste in ASTs under a roof (Refs. 23, pp. 1, 11, 12; 25, p. 16; 36, p. 3). Ecoflo was also permitted for air emissions for tanks, household hazardous waste, and National Pollutant Discharge Elimination System (NPDES) stormwater (Refs. 23, p. 2; 34).

Wastes present at the Ecoflo facility have changed according to customer demands through the years. Consistent wastes are 1,1-DCA, 1,1-DCE, 1,1,1-TCA, TCE, polychlorinated biphenyls (PCB), PCE, and waste water containing solvents from production, among others. (Refs. 33, pp. 6 to 16; 46, p. 9). ASTs and USTs were removed prior to any site inspections; however, there is no information regarding post-closure sampling in the file material.

Multiple releases of hazardous substances have been documented at the Ecoflo facility. During an inspection on December 15, 2006, two separate incidences occurred (Ref. 38, p. 1). The first incident was formation of a white cloud near the paint consolidation room caused by a chemical reaction from mixing lab pack acids and corrosives despite an earlier check for compatibility. Throughout the emergency, the inspector witnessed communication issues between employees regarding the chemical cloud, and lack of appropriate personal protective equipment (PPE). The second incident was a chemical spill from the back of a trailer into the Ecoflo parking lot. Employees responded to the spill immediately and began pouring adsorption materials onto the spill area. The source of the spill was ponded liquid in the back of the truck. The inspector observed no locking bars inside the truck and no placards on the outside (Ref. 38, p. 2). In 2009, a third incident was recorded during an un-manifested waste delivery of 21 55-gallon drums to Sumter, South Carolina. The generator, Ecoflo, was unaware that the delivery contained Toxic Substance Control Act (TSCA)-regulated levels of PCBs—revealed after laboratory testing. The source of the PCBs was unknown (Ref. 37, pp. 1, 2).

In addition to the three incidents, two warning letters have been issued by NCDENR (now NCDEQ) to Ecoflo regarding its hazardous waste storage management. In 2007, Ecoflo was issued a warning regarding three containers that had been stored for longer than 1 year (Ref. 64, p. 1). In 2013, Ecoflo was issued a second warning letter regarding four containers and one tote observed with conflicting labels during an inspection (Refs. 63; 64). In 2017, a focused compliance evaluation inspection found that the facility was not in full compliance with several requirements of RCRA; notably, Ecoflo had failed to conduct integrity testing on hazardous waste tanks as required by the permit (Ref. 32, pp. 1, 4).

#### ***2.2.3.2 Previous Investigations at Ecoflo***

Groundwater sampling at Ecoflo has been ongoing since November 1998 (Ref. 46, p. 1). Recent analytical results indicated the presence of cis-1,2-DCE, PCE, 1,1,1-TCA, TCE, barium, cadmium, and chromium in groundwater above laboratory quantitation limits (Ref. 33, pp. 1, Table 2).

#### **2.2.4 Former NC DOT Facility**

The following subsections describe the operational and regulatory history for the former NC DOT facility, as well as the previous investigations at the facility.

##### ***2.2.4.1 Regulatory and Operational History for the Former NC DOT Facility***

From about 1950 to the early 1990s, the former NC DOT facility at 1124 South Holden Road utilized several solvents at the asphaltic testing laboratory. The property is currently owned by Norfolk Southern Company and is leased to Hammaker East, Ltd. (Refs. 44, p. 1; 52, p. 2). During a site assessment in April 1998, groundwater samples were found to contain levels of carbon tetrachloride, 1,2-DCA, 1,1-DCE, 1,1,1-TCA, and TCE exceeding NCAC 2L GWQSs (Ref. 41, p. 27). In the early 1990s, the facility was transferred to Norfolk Southern Company and was leased to Thompson Arthur Paving Company (TAPCO) (Ref. 40, p. 16). The former laboratory space used by NC DOT is still present on site but is now used for construction material storage (Ref. 41, p. 14). A comprehensive site assessment in December 1998 determined the magnitude and extent of soil and groundwater contamination. Soil samples did not contain hazardous substances at concentrations above removal levels; however, groundwater samples contained hazardous substances at concentrations above NCAC 2L GWQSs (Ref. 42, p. 2). A “natural attenuation” corrective action plan was proposed on February 28, 2002, to include

excavation and removal of contaminated soil to reduce groundwater contamination (Ref. 40, p. 22; 42, p. 2).

Hazardous substances associated with the former NC DOT facility include carbon tetrachloride, 1,1,1-TCA, and muriatic acid (Refs. 16, pp. 16, 21; 39, p. 2-2; 40, p. 6). Elevated levels of chlorinated solvents were consistently detected near a drum storage area (Ref. 41, p. 15). Soil samples in chemical storage areas collected at the former NC DOT facility contained benzene, cis-1,2-DCE, ethylbenzene, isopropylbenzene, naphthalene, toluene, and xylenes, among others (Ref. 41, p. 24, Table 6-2, Figure 5-1). Remediation efforts involving chemical cleanup were proposed, but no available documentation indicates that these remediation efforts occurred on the site.

#### ***2.2.4.2 Previous Investigations at the Former NC DOT Facility***

From 2012 to 2015, CATLIN Engineers and Scientists (CATLIN) conducted annual groundwater sampling at the TAPCO facility. Periodically, sampling events have included groundwater gauging and groundwater elevation measurements (Ref. 52, pp. 3, Table 1, Table 2). Analytical results from the 2013 groundwater samples indicated the presence of carbon tetrachloride, 1,1-DCA, 1,1-DCE, cis-1,2-DCE, TCE, and vinyl chloride at concentrations above their respective NCAC 2L GWQSs. The highest concentrations of chlorinated solvents were found near the ASTs and former NC DOT laboratory (Refs. 42, Fig. 6A to 11C; 44, p. 7, Table 3; 49, pp. 25 to 42, Table 1, Table 2; 52, Table 3, Table 4). Concentrations of chlorinated aliphatic hydrocarbons (mainly TCE and 1,1-DCE) have decreased overall since monitoring events began. This suggests occurrence of natural biodegradation at the facility (Ref. 44, p. 7). During the June 2014 sampling, analytical results from groundwater samples indicated the presence of carbon tetrachloride, 1,1-DCE, 1,1-DCA, cis-1,2-DCE, and TCE, among others above NCAC 2L GWQSs (Ref. 52, pp. 6, 7, Table 3). The highest concentrations of VOCs were found in deep monitoring well DMW-30, located between the scale house/office and the ASTs in the northern portion of the facility (Ref. 52, Table 3, Figure 2).

#### **2.2.5 Other Facilities**

The following subsections describe the operational and regulatory histories for other facilities that could have contributed to the contamination at the Patterson Street site, as well as previous investigations.



### ***2.2.5.1 Regulatory and Operational Histories for Other Facilities at Patterson Street Site***

The Patterson Street site is in an industrial area occupied by several chemical manufacturing distribution, transportation, and warehousing facilities. Many facilities could have contributed to the solvent plume including but not limited to Ashland Chemical, Dow Corning, Ecoflo, and the former NC DOT facility (Ref. 7). The Patterson Street site is bordered to the north by the Norfolk Southern Railway facility, constructed in 1915 (Ref. 39, p. 2-1). From 1963 to 1967, several small industrial businesses operated on the property. In 1967, a portion of the property was leased by the Myers Brothers, a scrap metal recycling company until 2003 (Ref. 39, p. 2-1). In 2008, PCE and TCE were discovered in the eastern portion of the Norfolk Southern Railway property where 1,900 drums were stored. SVOCs and PCBs were detected in the soil, but not in groundwater (Ref. 39, p. 2-1). A former small, industrial pond with high levels of TCA and TCE was present on the property, north of the Dow Corning tank farm (Ref. 16, p. 33).

From 1895 to 1950, a cotton mill operated on a property north of Dow Corning. In 1950, the property was repurposed as an electronics manufacturer. From 1976 to 2001, various businesses operated on the property until the building was demolished in 2001 (Ref. 39, p. 2-2). Investigations at the former cotton mill site from 1998 to 2004 revealed the presence of industrial ponds, solvent storage areas, and ASTs and USTs on the property. VOCs and metals were detected in vadose zone soils, and DNAPL was suspected to have impacted groundwater downgradient of the site (Ref. 39, pp. 2-2, 2-3).

Several other facilities along Patterson Street removed USTs from their premises during the early 1990s and it may have contributed to the groundwater solvent plume—including North Railway (north of the Patterson Street site), ACI Distribution (east of Ecoflo), and LA Benson Tools (east of ACI Distribution), Johnston Properties, and Chemicals and Solvents (ChemSolv). Other nearby facilities that did not utilize USTs but could be potential contributors to groundwater contamination include Tritex Chemical Corporation (Tritex), Sunset Dry Cleaners and Sherwin Williams (Ref. 8, p 3-4, Figure 3-2). Operational and regulatory histories for these facilities are unknown.

### ***2.2.5.2 Previous Investigations at Other Facilities***

#### **Johnston Properties**

In September 2010, Arcadis conducted indoor air sampling and grout sealing for potential routes of entry on the Johnston Properties adjacent to Ashland Chemical. Arcadis collected six indoor air samples and one outdoor air sample (Ref. 47, pp. 1, 2, 12). Analytical results indicated the presence of chloroform,



ethylbenzene, PCE, and TCE at concentrations exceeding NC Inactive Hazardous Site Branch (IHSB) Indoor Air Screening Levels (IASL) (Ref. 47, pp. 2, 9). PCE and TCE were detected in all indoor samples; the highest concentrations of VOCs were detected in the bathroom (VIA-3) (Ref. 47, p. 9).

#### ChemSolv

In October 1989, soil sampling in connection with a sale of the business to Southchem, Inc. occurred around the entire ChemSolv facility (Ref. 45, pp. 1, 5). Analytical results indicated the presence of carbon tetrachloride, 1,1-DCA, 1,1-DCE, trans-1,2-DCE, ethylbenzene, methylene chloride, PCE, 1,1,1-TCE, toluene, and total xylenes (Ref. 45, pp. 2, 3).

In 2010, Arcadis, on behalf of Ashland Chemical, performed a RCRA facility investigation of the former ChemSolv property (adjacent to the former Ashland Chemical property), which included soil and groundwater investigations (Ref. 11, p. 4). Soil samples were collected from eight soil borings (Ref. 11, p. 6). Analytical results from the soil samples indicated the presence of VOCs benzene, 2-butanone, 1,2-dichlorobenzene, ethylbenzene, 1,1-DCA, 1,1-DCE, cis-1,2-DCE, methylene chloride, PCE, 1,1,1-TCA, TCE, and total xylenes, as well as SVOCs 1,4-dichlorobenzene, 1,2,4-trichlorobenzene, and 2,4-dimethylphenol above the NCDENR maximum soil contaminant concentrations (MSCC) and EPA residential screening levels (RSL) (Ref. 11, p. 8). Samples collected from the groundwater monitoring wells indicated the presence of VOCs benzene, 1,1-DCA, 1,1-DCE, cis-1,2-DCE, methylene chloride, PCE, 1,1,1-TCA, TCE, and total xylenes among others, above NCAC 2L GWQSs (Ref. 11, p. 9).

Arcadis concluded that ChemSolv was likely a source of chlorinated and non-chlorinated impacts on soil and groundwater and suggested additional sampling to assess ecological and human health risks to the area (Ref. 11, pp. 8, 9, 11, 14 to 19). Soil samples collected at the ChemSolv facility during 2010 contained the following at indicated maximum concentrations: 1,1-DCA at 31,000 µg/kg; 1,1-DCE at 7,600 µg/kg; PCE at 220,000 µg/kg; 1,1,1-TCA at 270,000 µg/kg; TCE at 130,000 µg/kg; toluene at 190,000 µg/kg; total xylenes at 1,300,000 µg/kg; and others (Refs. 11, pp. 14 to 18).

On February 9, 2016, S&ME, on behalf of the NCDEQ, conducted a soil and groundwater assessment at the ChemSolv property as part of an investigation of nearby residential areas (Ref. 54, p. 1). VOCs were detected in soil gas and groundwater. PCE and TCE were reported in soil gas samples at levels above residential vapor intrusion NC Department of Waste Management (WM) soil gas screening levels (SGSL) (Ref. 54, pp. 4, Table 5). PCE and TCE were also reported at levels above NCAC 2L GWQSs in groundwater samples (Ref. 54, pp. 4, Table 6).

### Patterson Street

In June and October 2016, S&ME, on behalf of NCDEQ, performed a crawl space and indoor air investigation of six residential properties on Camborne Street, south of Patterson Street (Ref. 4, pp. 1, 2, 11). The purpose of this investigation was to assess potential vapor intrusion risks in the area (Ref. 4, p. 1). During the investigation, five crawl space air samples and two indoor air samples were collected (Ref. 4, p. 2). Indoor air sample results indicated presence of TCE at concentrations exceeding the NC WM Indoor Air Screening Level (IASL) (Ref. 4, pp. 3, 12). Crawl space air sample results indicated the presence of 1,1-DCA, 1,2-DCA, PCE, and TCE at concentrations greater than IASLs (Ref. 4, pp. 3, 12). Ambient air sample results indicated the presence of 1,1-DCA, 1,1-DCE, cis-1,2-DCE, 1,1,1-TCA, and TCE at concentrations exceeding IASLs (Ref. 4, pp. 3, 12). Temporary air filters were offered to residents to reduce health risks until installations of mitigation systems, or more permanent filter systems, could occur (Ref. 56, p. 1).

In May 2017, on behalf of the EPA, Tetra Tech, conducted an assessment to determine if conditions warranted a removal action, utilizing findings from the S&ME/NCDEQ investigation. The assessment included groundwater, crawl space air, soil gas, and surface water sampling (Ref. 58, p. 2). Exterior soil gas results indicated the presence of 1,1-DCA, ethylbenzene, PCE, and TCE at concentrations exceeding EPA vapor intrusion screening levels (VISL) (Ref. 58, p. 4). Crawl space air sample results indicated the presence of benzene, ethylbenzene, PCE, TCE, and naphthalene at concentrations exceeding EPA VISLs (Ref. 58, p. 4). Groundwater results indicated presence of PCE at concentrations exceeding EPA VISLs in permanent monitoring wells (Ref. 58 p. 4). The four of the monitoring wells are upgradient of the area of concern. Surface water sampling results indicated the presence of PCE, TCE, and vinyl chloride at concentrations exceeding NCAC 2B surface water standards (Ref. 58, p. 5).

In March 2018, Tetra Tech, on behalf of EPA and NCDEQ, performed a removal assessment at the Patterson Street site (Ref. 60, p. 1). Results of the “Stage 1” assessment indicated the presence of PCE and TCE in each of the four-media sampled: soil gas, crawl space air, groundwater, and surface water (Ref. 60, p. 2). Five of the 12 proposed additional soil gas locations were sampled, and analytical results indicated the presence of naphthalene and 1,3-butadiene at concentrations exceeding EPA VISLs (Ref. 60, pp. 2, 3). The assessment concluded that the east – west extent of the plume was tentatively defined. The extent of the plume to the south was not determined (Ref. 60, p. 3).

## **2.3 PRELIMINARY ASSESSMENT SOURCE AND WASTE CHARACTERISTICS**

The Site is evaluated as a VOC groundwater plume impacting a residential area, with no discernible source. The suspected sources are numerous, as described above. Spills and releases from ASTs, USTs, areas of contaminated soil, and other releases on the facilities listed in Section 2.2 of this PA, and potentially other facilities, may have resulted in a co-mingled groundwater plume, which is evaluated as the Patterson Street Solvent Plume. Releases from the facilities may be co-mingled forming a VOC groundwater plume and that cannot be separated from each other in this screening evaluation. Releases are also impacting surface water, soil gas, and indoor and ambient air.

Since 1988, numerous investigations have occurred within the Patterson Street area. Groundwater samples collected throughout the area have contained the following at indicated maximum concentrations: 1,1-DCE at 1,290,000 µg/L; PCE at 400,000 µg/L; 1,1,1-TCA at 210,00 µg/L; TCE at 6,500,000 µg/L; and vinyl chloride at 3,700 µg/L. Releases to groundwater are documented at the facilities discussed in Sections 2.2.1 to 2.2.5 and off their properties, including residential areas directly south of Patterson Street. These compounds are not naturally occurring, are not ubiquitous, and are solvents documented to have been used in industrial operations.

## **3.0 PATHWAYS**

This section discusses the groundwater migration, surface water migration, soil exposure and subsurface intrusion, and air migration pathways. Additionally, this section discusses targets associated with each pathway and draws pathway-specific conclusions. This section also lists data gaps identified during this PA.

### **3.1 GROUNDWATER MIGRATION PATHWAY**

This section describes the groundwater migration pathway, associated targets that may be affected by releases or potential releases, and recent groundwater studies conducted for each of the facilities included in the Patterson Street Solvent Plume site.

#### **3.1.1 Regional Geology**

Patterson Street Solvent Plume is in the north-central portion of the State, within the Piedmont physiographic province (Ref. 65, pp. 2, 4). The Piedmont province occupies about 45 percent of North

Carolina and lies between the Coastal Plain to the east and the Blue Ridge Mountains to the west (Ref. 66, p. A2). Topography of the Piedmont province consists of low, well-rounded hills and long, rolling, northeast-trending ridges. The tops of many ridges and interstream divides are relatively flat and are thought to be remnants of the Piedmont peneplain, an ancient erosional surface of low relief (Ref. 66, p. A3). The Piedmont province surface is 300 to 600 feet above mean sea level (msl) along the eastern border, and rises gradually to the west to about 1,500 feet above msl at the Blue Ridge front (Ref. 66, pp. A3, A6). The Patterson Street site is about 830 feet above msl (see Figure 1 in Appendix A).

The near-surface materials of the Piedmont province consist of a three-stage system that, in descending order, includes (1) regolith, (2) a transition zone, and (3) underlying fractured crystalline bedrock (Ref. 67, p. 8). The upper-most zone is the regolith, which may reach depths greater than 100 feet and is composed of saprolite, alluvium, and soil (Refs. 66, p. A6; 67, p. 9). The regolith zone consists of an unconsolidated or semi-consolidated mixture of clay and fragmental material ranging in grain size from silt to boulders (Ref. 67, p. 9). Saprolite, a clay-rich, residual material derived from in-place weathering of bedrock, is the dominant deposit in this unconsolidated zone (Ref. 67, p. 9). The transition zone, where unconsolidated material grades into bedrock, consists of saprolite and partially-weathered bedrock. Particle size ranges from silts and clays to large boulders of unweathered bedrock. Thickness of this zone depends on texture and composition of the parent rock (Ref. 67, p. 9). The fractured crystalline bedrock contains unweathered bedrock, sheet joints, and fractures. The uppermost part of the crystalline bedrock contains numerous closely spaced fractures; the number of fractures decreases with depth (Ref. 67, p. 9).

The geology of the Piedmont province is extremely complex (Ref. 66, p. A6). The Piedmont province is divided into a number of northeast-trending geologic belts, including the Carolina Slate Belt, the Raleigh Belt, the Charlotte Belt, the Kings Mountain Belt, and the Inner Piedmont Belt (Ref. 67, p. 8). Within a belt, the rocks are to some degree similar to each other in general appearance, metamorphic rank, structural history, and relative abundance of igneous, metaigneous, metasedimentary, and metavolcanic rocks (Ref. 66, p. A8). Bedrock within the Piedmont province consists of folded and fractured metamorphosed sedimentary and igneous basement rocks. Typical bedrock lithologies include granite, gneiss, schist, quartzite, slate, and phyllite (Ref. 67, p. 7). The Patterson Street site lies near the western edge of the northern half of the Carolina Slate Belt (Ref. 66, p. A11). This area contains metaigneous, felsic rocks that are light colored, massive to foliated metamorphosed bodies of varying assemblages of felsic intrusive rock types; local shearing and jointing are common (Ref. 66, pp. A7, A10). Metamorphism of the rocks varies in degree of recrystallization and destruction of the original texture. The rocks are broken and displaced by numerous faults and zones of shearing. All rocks have been

subjected to uplift, weathering, and erosion, which resulted in widening and formation of new openings, such as stress-relief fractures. These breaks in the otherwise solid rock are conduits for groundwater flow (Ref. 66, p. A6).

### **3.1.2 Regional Hydrogeology**

Groundwater occurs in the unsaturated zone of the regolith, saturated zone of the regolith, transition zone between the regolith and bedrock, and the fractured crystalline bedrock system. The unsaturated zone extends from land surface to the water table, which is the top of the saturated zone and ranges from 5 to 50 feet in thickness (Ref. 67, p. 12). The water table is generally encountered at about 20 to 32 feet bgs (Ref. 67, p. 15). The regolith saturated zone is the interval below the water table and above the transition zone, and is about 13 feet thick. The saturated zone provides the bulk of water storage in the Piedmont groundwater system (Ref. 67, pp. 13, 14). The regolith serves as a reservoir supplying water to interconnected fractures within the bedrock. Generally, wells in the Piedmont area are cased through the regolith and completed as open holes in the bedrock. The bedrock fractures serve as pipelines between the well and the regolith reservoir (Ref. 67, p. 15). The transition zone is at the base of the regolith, is about 15 feet thick, is highly permeable, and consists of weathered rock, boulders, and saprolite (Ref. 67, p. 17). The high permeability of the transition zone is due to incomplete weathering of the upper regolith, which may create a zone of concentrated flow within the groundwater system (Ref. 67, pp. 17, 19). Groundwater flow within the crystalline bedrock occurs within fracture systems. Fracture openings are wider near the bedrock surface, and decrease in size and number with depth (Ref. 67, p. 20).

The Piedmont groundwater system serves two functions: it stores water to the extent of its porosity, and it transmits water from recharge areas to discharge areas. Thus, the groundwater system serves as both a reservoir and a conduit, and is directly connected to the surface water system (Ref. 67, pp. 22, 23). For example, annual contribution of groundwater to total streamflow for 11 streams flowing through the Piedmont is estimated at 44 percent (Ref. 67, p. 23).

### **3.1.3 Site Geology**

Geology at the Patterson Street site reflects the regional geology of the Carolina Slate Belt. The regolith consists of the soil layer and saprolite. The soil layer is about 3 feet thick and consists of dark brown to black clayey silt to silty clay with a high concentration of organic material. The saprolite consists of fine sandy silts to silty sands weathered from parent material, and is the dominant feature of the regolith. Its

thickness ranges from 3 to 37 feet (Ref. 68, p. 2-3). The transition zone is beneath the regolith, and consists of clay to silty sand, with fragments of white feldspar, amphiboles, and minor quartz (Ref. 68, p. 2-4). The transition zone occurs between 15 and 37 feet bgs, and is about 12 to 17 feet thick. During installation of a well at the Patterson Street site area, bedrock was encountered at 51 feet bgs and consisted of moderately to slightly weathered, moderately hard to hard white and dark green porphyritic to aphanitic diorite in closely spaced fracture joints (Ref. 68, p. 2-4).

#### **3.1.4 Site Hydrogeology**

The groundwater system at the Patterson Street site is similar to regional hydrogeology, and is composed of, in descending order, (1) saturated saprolite consisting of weathered bedrock with little residual structure; (2) transition zone, less weathered, which is more transmissive and retains the fracture structure and pattern of the underlying bedrock; and (3) bedrock zone (Ref. 68, p. 2-6). Descriptions of these hydrogeologic zones appear in boring logs recorded in the Patterson Street site area (Ref. 68, p. 57).

The saprolite zone is reddish-brown in color; is composed of fine sand, silt, and clay; and contains relict bedrock features, such as mineral grains. Generally, thickness of the saprolite ranges from 50 to 70 feet, but is only 10 to 20 feet thick near streams (Ref. 69, pp. 4-4, 4-5).

The transition zone separates the saprolite and the fractured bedrock, and is divided into two sub-units, the unconsolidated zone and a highly-fractured rock zone (Ref. 69, p. 4-5). The unconsolidated transition zone is composed of a mixture of sand and gravel-sized fragments of weathered bedrock, and the fractured rock transition zone is composed of highly fractured bedrock. Boring logs advanced in the Patterson Street site area indicate encounter with the transition zone at depths ranging from 10 to 85 feet bgs, with thicknesses ranging from 15 to 64 feet (Ref. 69, p. 4-5).

The fractured bedrock zone is composed of gneissic granite with schist layers and diorite with veins of quartz and feldspar (Ref. 69, p. 4-6). Topography of the bedrock surface is highly variable. Top of bedrock was encountered at depths ranging from 55 to 124 feet bgs (Ref. 69, p. 4-6). Fracture frequency and orientation were measured at three monitoring well locations, and fracture characteristics differed at each location. Additionally, results of aquifer pump tests indicated hydraulic conductivity differences of two to three orders of magnitude within wells about 170 feet apart. The varying depths at which bedrock was encountered, differences in fracture frequency and orientation, and vastly different hydraulic

conductivities within short distances highlight the extremely complex subsurface conditions in the Patterson Street site area (Ref. 69, p. 4-7).

### 3.1.5 Groundwater Sampling Results

Numerous groundwater investigations have occurred at and near industrial facilities in the study area. The following paragraphs summarize the most recent investigations at each facility that document releases of chlorinated solvents throughout the Patterson Street study area.

In 2010, Arcadis conducted groundwater sampling at the ChemSolv facility as part of a Phase III RCRA Facility Investigation (Ref. 11, p. 4). Analytical results from groundwater samples indicated the presence of benzene, 1,1-DCE, cis-1,2-DCE, PCE, 1,1,1-TCA, toluene, and total xylenes, among others above NCAC 2L GWQSSs. The highest concentrations of 1,1-DCE (11,000 µg/L), PCE (13,000 µg/L), toluene (120,000 µg/L), and TCE (9,000 µg/L) were detected in a soil boring, SB-45, directly north of the main building (Ref. 11, pp. 19, 22).

In October 2013 and June 2014, CAITLIN Engineers and Scientists (Caitlin) conducted groundwater sampling as part of a monitoring event at the former NC DOT facility (Ref. 42, p. 1; 52, p. 1). During the October 2013 sampling, analytical results indicated the presence of carbon tetrachloride, 1,1-DCA, 1,1-DCE, cis-1,2-DCE, TCE, and vinyl chloride above NCAC 2L GWQSSs. The highest concentrations of carbon tetrachloride (5.8 µg/L), 1,1-DCA (45.5 µg/L), 1,1-DCE (327 µg/L), cis-1,2-DCE (1,040 µg/L), TCE (1,200 µg/L), and vinyl chloride (6.1 µg/L) were detected in the northern portion of the property east and northeast of the facility's ASTs (Ref. 42, pp. 52, 53, 102). Analytical results from groundwater samples collected in June 2014 indicated the presence of carbon tetrachloride, 1,1-DCE, cis-1,2-DCE, TCE, and vinyl chloride among others above NCAC 2L GWQSSs (Ref. 52, pp. 9, 40, 41). The highest concentrations of carbon tetrachloride (5.9 µg/L), 1,1-DCE (771 µg/L), cis-1,2-DCE (397 µg/L), TCE (4,650 µg/L), and vinyl chloride (4.6 µg/L) were detected in a deep monitoring well between the scale house/office and the ASTs in the northern portion of the facility (Ref. 52, pp. 40, 41, 76).

In April 2014 and April 2015, URS performed groundwater sampling at the Dow Corning facility during a semi-annual groundwater monitoring event to assess the presence and magnitude of natural attenuation parameters in groundwater at the site (Refs. 51, pp. 1-1, 4-1; 53, p. 5). In April 2014, analytical results from groundwater samples indicated the presence of cis-1,2-DCE, PCE, 1,1,1-TCA, TCE, and vinyl chloride, among others above NCAC 2L GWQSSs (Ref. 51, p. 4-1, Table 3, Table 4). Samples were



collected within the HWMU area and around Building #3. The highest concentrations of PCE (130 µg/L), and TCE (1,900 µg/L), and vinyl chloride (2,000 µg/L) were detected within the HWMU area, while the highest concentration of cis-1,2-DCE (230 µg/L) was detected around Building #3 (Ref. 51, Table 3, Table 4, Figure 3). In April 2015, analytical results from groundwater samples collected from around the HWMU and Building 3 indicated presence of 1,1-DCE (2,400 µg/L), PCE (72 µg/L), 1,1,1-TCA (380 µg/L), TCE (780 µg/L), and vinyl chloride (1,500 µg/L) above their respective NCAC 2L GWQSs (Ref. 53, pp. 21 to 24, 33).

In 2016, Arcadis, on behalf of the NCDEQ, conducted annual groundwater and semi-annual surface water sampling at the former Ashland Chemical facility (Ref. 57, p. 1). Analytical results from monitoring well samples indicated the presence of 1,1-DCA, 1,1-DCE, 1,1-DCE, cis-1,2-DCE, 1,1,1-TCA, TCE, PCE, and 1,4-dioxane at concentrations above their respective NCAC 2L GWQSs (Ref. 57, pp. 8, 9, 10). Analytical results from surface water samples indicated the presence of PCE at concentrations greater than the NCAC 2B surface water standards and 1,1-DCE, cis-1,2-DCE, and TCE were detected at concentrations less than NCAC 2B surface water standards (Ref. 57, Table 3). The highest concentrations of 1,1-DCA (1,200 µg/L), 1,1-DCE (2,200 µg/L), cis-1,2-DCE (9,700 µg/L), 1,1,1-TCA (3,600 µg/L), TCE (12,000 µg/L), and PCE (53,000 µg/L) were detected south of the former AST and UST locations (Ref. 57, pp. 8, 9, 10, Figure 1).

In July 2018, Golder Associates performed groundwater sampling at the Ecoflo facility during annual groundwater monitoring (Ref. 33, p. 1). Analytical results from groundwater samples indicated the presence of cis-1,2-DCE, PCE, 1,1,1-TCA, and TCE among others (Ref. 33, pp. 2, Table 2). The highest concentrations of cis-1,2-DCE (320 µg/L), PCE (43,000 µg/L), and TCE (25,000 µg/L) were detected in groundwater samples collected northern portion of the property (Ref. 33, pp. Table 2, Figure 1).

### **3.1.6 Groundwater Migration Pathway Targets**

Municipal water within a 4-mile radius of the Patterson Street site is provided by the City of Greensboro, which maintains surface water intakes on Lake Higgins, Lake Brandt, and Lake Townsend in northern Guilford County (Ref. 61, p. 1). No private wells are known to be used for drinking water or resources within the 4-mile radius of the Patterson Street site.



### 3.2 SURFACE WATER MIGRATION PATHWAY

The 2-year, 24-hour rainfall event for the area is 3.5 inches (Ref. 72, pp. 51). Normal, annual, total precipitation in the area is approximately 45 inches, and mean annual evaporation is approximately 41 inches, yielding a net annual precipitation of about 4 inches (Refs. 28, p. 1; 73, p. 6). According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM), Panel No. 7854, the Patterson Street site is within Zone X (unshaded): “Areas outside the 1% annual chance floodplain” (Ref. 74).

Based on the site’s topography and surface water runoff from the Patterson Street site drains southeast toward intermittent unnamed tributaries of South Buffalo Creek (Ref. 8, pp. 3-3, Figure 3-3). From Patterson Street, the two unnamed intermittent tributaries flow south to South Buffalo Creek (Refs. 35; 70). South Buffalo Creek flows northeast for about 15 where it completes the 15-mile surface water migration pathway target distance limit (TDL) (Refs. 35; 70).

Tetra Tech did not observe fish or signs of fishing in South Buffalo Creek. Fishing advisories for largemouth bass, bluegill, sunfish, trout, blackfish, wild catfish, jackfish, warmouth, and yellow perch regarding mercury pollution have been issued statewide (Ref. 76).

Municipal water in the City of Greensboro is provided from three surface water sources: Lake Higgins, Lake Brandt, and Lake Townsend, in northern Guilford County outside of the 15-mile TDL (Refs. 35; 61, p. 1). In 2017, Greensboro purchased water from Burlington, Reidsville, Winston-Salem, and the Piedmont Triad Regional Water Authority (PTRWA), all of which obtain their drinking from surface water intakes (Ref. 61, p. 1). The PTRWA obtains drinking water from the Randleman Regional Reservoir, a man-made reservoir at the confluence of Muddy Creek and the Deep River (Ref. 71, p. 1). Neither the Randleman Regional Reservoir nor Muddy Creek or the Deep River is within the 15-mile surface water migration pathway TDL (Refs. 35; 70; 71, p. 1).

Several federally at risk, threatened, or endangered species occurred in Guilford County, North Carolina, as of October 4, 2018 (Ref. 77). The Bald eagle (*Haliaeetus leucocephalus*) is protected under the Bald and Golden Eagle Protection Act. The only at-risk species in the area is the Atlantic pigtoe (*Fusconaia masoni*). The only threatened species in the area is the Small whorled pogonia (*Istoria medeoloides*). Endangered species in the area include the Cape Fear shiner (*Notropis mekistocholas*), Roanoke logperch

(*Percina rex*), and the Schweinitz's sunflower (*Helianthus schweinitzii*). All species are of current record status (Ref. 77). There are no records of fishing in South Buffalo Creek (Ref. 78).

HRS-eligible wetlands are along the 15-mile surface water migration pathway TDL (Refs. 35; 70).

Within the 15-mile TDL, total frontage for freshwater emergent and freshwater forested/shrub wetlands along South Buffalo Creek and North Buffalo Creek is about 2.81 miles (Refs. 35; 70). Average flow rate in South Buffalo Creek is 225.54 cubic feet per second (ft<sup>3</sup>/sec) (Ref. 75).

Surface water samples collected from the unnamed tributaries of South Buffalo Creek in a residential area in the Patterson Street study area contained the following, with maximum concentrations indicated: PCE at 410 µg/L; TCE at 530 µg/L; and vinyl chloride at 5.7 µg/L—all exceeding 15A NC Surface Water Standards for Human Health. (Refs. 57, pp. 3, Table 3). Surface water samples also contained 1,1-DCA, 1,1-DCE, *cis*-1,2-DCE, and 1,1,1-TCA, among others, at concentrations below 15A NC Surface Water Standards for Human Health (Refs. 48, Table 7; 50).

### **3.3 SOIL EXPOSURE AND SUBSURFACE INTRUSION PATHWAY**

This section describes the soil exposure and subsurface intrusion components of the soil exposure and subsurface intrusion pathway.

#### **3.3.1 Soil Exposure Component**

Land use in the Patterson Street study area is a mixture of industrial, commercial, and residential (Ref. 16, Figure 1-1; 58, Figure 1). The Patterson Street study area is bordered to the north by Norfolk Southern railroad tracks with commercial and residential properties beyond; to the east by High Point Road with commercial and residential properties beyond; to the south by West Florida Street with commercial and residential properties beyond; and to the west by Merritt Street with commercial and residential properties (see Figure 2 in Appendix A). Topography of the Patterson Street site slopes to the south and east toward unnamed intermittent tributaries of South Buffalo Creek (see Figure 1 and Figure 2 in Appendix A). Access to properties within the Patterson Street site is unrestricted, and access to facilities at the site is via entrances along Patterson Street (see Figure 2 in Appendix A). Soil samples have not been collected on residential properties.

The nearest residence is on Camborne Street about 700 feet south of the Patterson Street and South Holden Road intersection (Ref. 4, Table 1; see Figure 2 in Appendix A). The nearest school (Hunter Elementary School) is about 3,500 feet southwest of the intersection of Patterson Street and South Holden Road (see Figure 1 in Appendix A). About 9,044 people reside within 1 radial mile of the Patterson Street site. The residential population within a 1-mile radius is distributed as follows: >0 to 0.25 mile, 246 persons; >0.25 to 0.50 mile, 1,871 persons; >0.50 to 1.0 mile, 6,927 persons (Ref. 80).

### **3.3.2 Subsurface Intrusion Component**

A complete vapor intrusion pathway consists of five elements: (1) a subsurface source of vapor-forming chemicals is present beneath and near a building; (2) vapors form and have a route along which to migrate toward the building; (3) the building is susceptible to soil gas entry, which means openings exist for the vapors to enter the building; (4) vapor-forming chemicals comprising the subsurface vapor source are present in the indoor environment; and (5) the building is occupied when these chemicals are present indoors (Ref. 55, p. 22).

#### ***3.3.2.1 Subsurface Intrusion Component Sampling Results***

In August 2010, Arcadis conducted exterior soil gas sampling at the former Ashland Chemical facility to assess the potential extent of soil and groundwater impacts. Soil gas samples contained 1,4-dichlorobenzene, cis-1,2-DCE, and total petroleum hydrocarbons (TPH) among others in the southern portion of the facility. The highest concentrations of PCE (2,214.78 micrograms per cubic meter [ $\mu\text{g}/\text{m}^3$ ]) and TCE (2,699.80  $\mu\text{g}/\text{m}^3$ ) were found within the southwestern portion of the site and migrating south at least to Camborne Street (Refs. 6, pp. 1, 4, 18, 21, 22).

Arcadis performed indoor air sampling at seven locations in the main building on the Johnston Properties (Ref. 47, pp. 1, 2, Figure 2). Initial sampling occurred on September 23 and 24, 2010, and resampling occurred in February 2011 after potential routes of entry in the building slab had been sealed (Ref. 47, pp. 1-3). A subcontractor was hired in 2011 to seal visible potential routes of entry through the concrete slab, including expansion joints, cracks, penetrations in the slab, and seams between the floors and walls (Ref. 47, p. 3). Resampling occurred in 2011; analytical results indicated that chloroform up to 1.3  $\mu\text{g}/\text{m}^3$ , ethylbenzene up to 11  $\mu\text{g}/\text{m}^3$ , PCE up to 380  $\mu\text{g}/\text{m}^3$ , and TCE up to 230  $\mu\text{g}/\text{m}^3$  were still present at levels above NC Inactive Hazardous Site Branch (IHSB) Industrial/Commercial IASLs, but these concentrations were significantly below the Occupational Safety and Health Association (OSHA) permissible exposure

limits (PEL) before and after the points of entry had been sealed (Ref. 47, pp. 2, 3). Based on these indoor air sampling results, Arcadis suggested implementation of a sub-slab depressurization system (Ref. 47, pp. 2, 4).

Starting in 2010, Arcadis documented the installation of sub-slab depressurization (SSD) systems at the Johnston properties after an air sampling event in September 2010 concluded the presence of constituents of potential concern (COPC) in indoor air (Ref. 30, p. 1). Analytical results of the September 2010 sampling indicated the presence of chloroform up to  $0.89 \mu\text{g}/\text{m}^3$ , PCE up to  $160 \mu\text{g}/\text{m}^3$ , and TCE up to  $150 \mu\text{g}/\text{m}^3$  (Ref. 30, Table 4). Visible expansion joints, cracks, and any other penetrations into the slab acting as potential routes of entry were sealed in January 2011 (Ref. 30, p. 1). Analytical results of post-joint sealing in February 2011 indicated the presence of chloroform up to  $1.3 \mu\text{g}/\text{m}^3$ , ethylbenzene up to  $11 \mu\text{g}/\text{m}^3$ , TCE up to  $230 \mu\text{g}/\text{m}^3$ , and PCE up to  $380 \mu\text{g}/\text{m}^3$  above the EPA RSLs (Ref. 30, pp. 2, Table 4). February 2011 sample results indicated an increase in COPC concentrations after visible joints had been sealed (Ref. 30, p. 2). In July 2012, two SSD mitigation systems were installed because of the increased concentrations of COPCs in the February 2011 sampling. An additional sampling after the installation of both SSD systems was conducted in December 2012. Analytical results of the December 2012 sampling indicated a decrease in primary COPCs (e.g PCE and TCE) although chloroform, ethylbenzene, methylene chloride, and xylenes remained above the EPA RSLs (Ref. 30, Table 4). The continuation of indoor air monitoring and quarterly reported for sub-slab vacuum measurements for Johnston Properties was recommended (Ref. 30, p. 7).

In February and June 2016, S&ME conducted sub-slab soil gas, ambient air, and indoor/crawl space air sampling at 12 different residential properties within the Patterson Street site (Refs. 4, p. 2; 54, pp. 1, 2). During the February sampling, the following VOCs were detected at the highest concentrations in soil gas samples collected within 2 and 3 feet bgs at 2838 Camborne Street: 1,1-DCE up to  $2,150 \mu\text{g}/\text{m}^3$ , cis-1,2-DCE up to  $8.92 \mu\text{g}/\text{m}^3$ , trans-1,2-DCE up to  $1.25 \mu\text{g}/\text{m}^3$ , PCE up to  $2,770 \mu\text{g}/\text{m}^3$ , and TCE up to  $1,070 \mu\text{g}/\text{m}^3$  (Ref. 54, Tables 1, 3, 5, Figure 4). The highest concentration of vinyl chloride ( $2.50 \mu\text{g}/\text{m}^3$ ) was detected within 9 to 10 feet bgs at 3302 Immanuel Road (Ref. 54, Tables 1, 3, 5, Figure 4). During the June sampling, the following VOCs were detected in crawlspace air: 1,2-DCA up to  $1.47 \mu\text{g}/\text{m}^3$ , 1,1-DCE up to  $57.4 \mu\text{g}/\text{m}^3$ , PCE up to  $41.3 \mu\text{g}/\text{m}^3$ , and TCE up to  $20.1 \mu\text{g}/\text{m}^3$  (Ref. 4, pp. 9, 12). 1,1-DCA, cis-1,2-DCE, and 1,1,1-TCA were also detected, but at concentrations below residential NC Division of Waste Management (DWM) IASLs (Ref. 4, p. 12). Temporary air filters were offered to residents until a more permanent solution (e.g., a mitigation system) could be installed (Ref. 56, p. 1).

According to the 2018 U.S. Census Bureau, 2.49 persons per household lived in Guildford County (Ref. 81, p. 2). Therefore, about 15 people resided in six homes where contaminants of concern (COC) had been detected. The estimated living area within these six residential properties sampled is about 6,626 square feet total (Ref. 79, pp. 1, 5, 9, 13, 17, 21).

In summary, the following factors suggest that the Patterson Street site may pose a risk to human health via subsurface intrusion:

- Site-related VOCs, including 1,2-DCA, 1,1-DCE, cis-1,2-DCE, PCE, TCE, and vinyl chloride, are present in soil, soil gas, and groundwater beneath the site.
- Vapors have formed and have entered multiple properties around the site through holes, joints, cracks, gaps, cuts, drains, and pipe penetrations in concrete.
- The VOCs cited above have been detected in crawlspace and ambient air samples.
- Residences and facilities within the Patterson Street site are currently occupied (Refs. 4, p. 2; 10, p. 3; 14, p. 3; 32, p. 7; 54, p. 1).

#### ***3.3.2.2 Subsurface Intrusion Component Targets***

Based on results presented in Section 3.3.2.1, areas of observed exposure and areas of subsurface contamination are present at industrial/commercial and residential properties. VOCs detected in indoor air samples at Johnston Properties include benzene, chloroform, methylene chloride, PCE, TCE, vinyl chloride, and xylenes, while those detected at residential properties along Camborne Street include benzene, 1,1-DCE, PCE, and TCE.

### **3.4 AIR MIGRATION PATHWAY**

In June 2016, S&ME collected an ambient air sample at a residence on Camborne Street, south of Patterson Street. The ambient air sample contained 1,1-DCE at 0.172  $\mu\text{g}/\text{m}^3$ , PCE at 0.237  $\mu\text{g}/\text{m}^3$ , 1,1,1-TCA at 0.346  $\mu\text{g}/\text{m}^3$ , and TCE at 0.131  $\mu\text{g}/\text{m}^3$  (Ref. 4, pp. 3, 9, 12; see Figure 2 in Appendix A).

Based on those June 2016 S&ME sample results, Tetra Tech collected two additional ambient air samples in October 2016 along Camborne Street (Ref. 58, pp. 1, 2, Figure 3). The ambient air samples contained benzene at 0.98  $\mu\text{g}/\text{m}^3$  and TCE at 0.73  $\mu\text{g}/\text{m}^3$ —which are concentrations above their respective EPA Residential IASLs (Ref. 58, Table 2).

About 9,044 people live within 1 radial mile of the Patterson Street site, and about 133,924 people live within 4 radial miles of the Patterson Street site. The residential population within a 4-mile radius is distributed as follows: >0 to 0.25 mile, 246 persons; >0.25 to 0.50 mile, 1,871 persons; >0.50 to 1.0 mile, 6,927 persons; >1.0 to 2.0 miles, 28,948 persons; >2.0 to 3.0 miles, 46,514 persons; >3.0 to 4.0 miles, 49,418 persons (Ref. 80).

In summary, the Patterson Street site is located in a mixed industrial, commercial, and residential area. Several factors suggest that the Patterson Street site may pose a risk to human health via air migration, and site-related VOCs have been detected in the ambient air and within the Patterson Street site boundary (Refs. 4, pp. 9, 12; 58, Figure 3, Table 2). About 246 people reside within 0.25-mile of the Patterson Street site (Ref. 80).

### 3.5 DATA GAPS

The following data gaps were identified during this PA:

- Operational and regulatory histories of several potential sources are not available, including Norfolk Southern Railway, a cotton mill north of Dow Corning, ChemSolv, Tritex, Sunset Dry Cleaners, and Sherwin Williams (Refs. 8, p. 3-4, Figure 3-1; 39, pp. 2-1, 2-2, 2-3).
- According to available file information, source samples have not been collected at the following Patterson Street facilities: Ecoflo, Norfolk Southern Railway, a cotton mill north of Dow Corning, Tritex, Sunset Dry Cleaners, and Sherwin Williams (Refs. 8; 16; 23; 39; 44, pp. 2, 3).
- It is not known whether Ecoflo ever had subsurface injections, landfills, or incinerators, or whether those waste disposal areas were present.
- More than 100 monitoring wells have been installed at the Patterson Street site; however, only one monitoring well (MW-30) has been installed near the neighborhood south of the site (Ref. 8, Figure 2-2). Additional monitoring wells are needed in this neighborhood to attain complete understanding of geological and hydrogeological conditions beneath the area surrounding the site.
- Ambient air samples were collected in June and October 2016; however, background ambient air samples have not been collected (Refs. 4, pp. 9, 12; 58, Figure 3, Table 2).

## 4.0 SUMMARY AND CONCLUSIONS

Several industrial facilities are within the Patterson Street site, including Ashland Chemical, Dow Corning, Ecoflo, and the NC DOT, among others. Facilities in the area are major suppliers of blended bulk chemicals to furniture, textile, and other manufacturing businesses. These facilities along Patterson

Street are involved or are suspected to be involved in chlorinated solvent releases to the surrounding area. The Patterson Street site encompasses approximately 100 acres of land.

Soil samples contained chlorinated solvents, including 1,1-DCA, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, PCE, 1,1,1-TCA, TCE, and vinyl chloride, among others. Groundwater samples collected from monitoring wells installed throughout the site contained 1,1-DCA, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, PCE, 1,1,1-TCA, TCE, and vinyl chloride, among others. Surface water samples collected from nearby tributaries to South Buffalo Creek contained 1,1-DCA, 1,1-DCE, cis-1,2-DCE, PCE, 1,1,1-TCA, TCE, and vinyl chloride, among others. Regionally, the Piedmont groundwater system serves two functions: it stores water to the capacity of its porosity, and it transmits water from recharge areas to discharge areas. Thus, the groundwater system serves as both a reservoir and a conduit and is directly connected to the surface water system.

Exterior soil gas samples collected within areas of the southern portion of the Patterson Street site contained 1,1-DCE, cis-1,2-DCE, trans-1,1-DCE, PCE, TCE, and vinyl chloride. Crawlspace and indoor air samples collected at businesses and residences within the southern portion of the Patterson Street site contained 1,1-DCE, cis-1,2-DCE, PCE, TCE, and vinyl chloride. Ambient air samples collected within the neighborhood in the southern portion of the Patterson Street site contained 1,1-DCE, PCE, and TCE.

The same chlorinated solvents found in soil samples were also found in groundwater, surface water, soil gas, and air.

Drinking water at the Patterson Street site and the surrounding area is provided by the municipal water supply of Greensboro, North Carolina, which obtains its drinking water from surface water. None of the surface water intakes used for drinking water is within the 15-mile surface water migration pathway TDL. About 2.81 miles of HRS-eligible wetlands are along the 15-mile surface water migration pathway TDL (Refs. 35; 70).

Based on a review of historical documentation, communications with NCDENR personnel, and available analytical data, Tetra Tech recommends further action under CERCLA at the Patterson Street site at the discretion of EPA.



## 5.0 REFERENCES

1. U.S. Environmental Protection Agency (EPA), Office of Emergency and Remedial Response. Guidance for Performing Preliminary Assessments under CERCLA. September 1991.
2. EPA, Office of Emergency and Remedial Response. Guidance for Performing Site Inspections Under CERCLA Interim Final. September 1992.
3. EPA. Hazard Ranking System Final Rule, 40 *Code of Federal Regulations* (CFR) Part 300. Vol. 55, No. 241. December 14, 1990.
4. S&ME, Inc (S&ME). Crawlspace and Indoor Vapor Sampling Chemical and Solvents, Inc. Site. October 10, 2016.
5. RUST Environment and Infrastructure, Inc. (RUST). Soil and Groundwater Assessment Report for Ashland Chemical, Inc. June 11, 1993.
6. Arcadis U.S., Inc. (Arcadis). Proposed Refinements to the Existing Remedial Strategy, Former Ashland, Inc. Facility. September 30, 2010.
7. Arcadis. RCRA Facility Investigation, Figure 2-4, Other Potential Sources within the Watershed of the Unnamed Stream. June 11, 2013.
8. Arcadis. Corrective Measures Study, Former Ashland Inc. Facility. October 3, 2014.
9. Sirrine Environmental Consultants (Sirrine). Underground Storage Tank Closure Report, Ashland Chemical Inc. August 25, 1992.
10. North Carolina Department of Environmental Quality (NCDEQ), Division of Waste Management, Hazardous Waste Section. Compliance Evaluation Inspection Report, Former Ashland, Inc. May 18, 2018.
11. Arcadis. Preliminary Results from Phase III RCRA Facility Investigation Conducted on the Former Chemicals and Solvents, Inc. Property. March 10, 2011.
12. North Carolina Department of Environment and Natural Resources (NCDENR), Division of Waste Management, Hazardous Waste Section. Compliance Evaluation Inspection Report, Dow Corning Corporation. June 23, 2010.
13. NCDENR, Division of Waste Management, Hazardous Waste Section. Compliance Evaluation Inspection Report, Dow Corning Corporation. October 9, 2014.
14. NCDENR, Division of Waste Management, Hazardous Waste Section. RCRA Compliance Evaluation Inspection Report, Dow Silicones Corporation. May 22, 2018.
15. NCDENR, Division of Waste Management. Final Administrative Order in Lieu of Post-Closure Permit, Dow Corning Corporation. September 14, 2011.
16. Shield Environmental Associates, Inc. (Shield Environmental). Phase III Site Investigation Report for Dow Corning Corporation, Greensboro Facility. March 1998.



17. NCDENR, Division of Waste Management, Hazardous Waste Section. Compliance Evaluation Inspection Report, Dow Corning Corporation. June 12, 2013.
18. U.S. Environmental Protection Agency. RCRA Info for Ashland, Inc. and Dow Corning. Date Accessed: February 7, 2019. Accessed online at: [https://ofmpub.epa.gov/enviro/rcrainfoquerty\\_3.facility\\_information?](https://ofmpub.epa.gov/enviro/rcrainfoquerty_3.facility_information?)
19. NCDENR, Division of Waste Management, Hazardous Waste Section. RCRA Compliance Evaluation Inspection Report, Dow Corning Corporation. August 31, 2017.
20. S&ME. Underground Storage Tank Removal, Dow Corning Corporation. November 7, 1994.
21. Shield Environmental. Former Hazardous Waste Management Unit Post-Closure Plan for Dow Corning Corporation. October 2002.
22. Shield Environmental. Hazardous Waste Management Unit Closure Plan, Dow Corning Corporation. Revised December 30, 1997.
23. Ecoflo, Inc. Hazardous Waste Management Permit Application, Volume 1, Revision 00. August 24, 2018.
24. Shield Environmental. Hazardous Waste Management Unit Closure Plan, Dow Corning Corporation, Third Revision. July 1999.
25. Ecoflo, Inc. Hazardous Waste Management Permit Application (Part A and Part B), Volume 1. May 2007.
26. Cardinal Resources. Revised Facility Site Conceptual Model, Dow Corning Greensboro Site. May 15, 2012.
27. Cardinal Resources. 2011 Building 1 Area Remedial Activities, Dow Corning Greensboro Site. December 27, 2011.
28. Greensboro, North Carolina Climate Summary. Date Accessed: February 27, 2019. Online Address: [www.bestplaces.net/climate/city/north\\_carolina/greensboro](http://www.bestplaces.net/climate/city/north_carolina/greensboro).
29. North Carolina Department of Human Resources, Division of Health Services. Notification of an Inactive Hazardous Substance or Waste Disposal Site, Dow Corning Corporation (Greensboro). March 28, 1988.
30. Arcadis. Sub-Slab Depressurization Completion Report for the Johnston Properties Building located at 2800 Patterson Street. February 21, 2013.
31. ENSR Consulting and Engineering, Inc. (ENSR). An Evaluation of Employee Exposure to Organic Vapors at Ecoflo: A Hazardous Waste Treatment, Storage and Disposal Facility. March 23, 2005.
32. EPA, Region 4. Opportunity to Show Cause, RCRA Compliance Evaluation Inspection, Ecoflo, Inc. August 14, 2017.

33. Golder Associates NC, Inc. 2018 Annual Groundwater Monitoring Report, Ecoflo, Inc. September 7, 2018.
34. ENSR. Hazardous Waste Management Permit Application (Part A and Part B), Volume 2. January 1995.
35. Tetra Tech, Inc. (Tetra Tech). 15-Mile Surface Water Migration Pathway Target Distance Limit. January 23, 2019.
36. NCDENR, Division of Waste Management. Resident Inspector Report, Notice of Violation, Ecoflo. December 9, 2009.
37. Giant Resource Recovery – Sumter, Inc. Unmanifested Waste Report-PCBs, Rejected Load Notice-PCBs, Ecoflo, Inc. September 25, 2009.
38. NCDENR, Division of Waste Management. RCRA Inspection Report, Ecoflo, Inc. August 11, 2006.
39. URS Corporation. Monitoring Well Installation and Groundwater Monitoring Report, Dow Corning Corporation. November 6, 2013.
40. CATLIN Engineers and Scientists (CATLIN). Corrective Action Plan, North Carolina Department of Transportation (NC DOT), Former Asphalt Material Testing, NCDOT Site #24-61, Volume 1. February 28, 2002.
41. CATLIN. Comprehensive Site Assessment, NC DOT Site #61. December 4, 1998.
42. CATLIN. Monitoring Report, October 2013 Sampling Event for NC DOT Former Site #24-61. June 6, 2014.
43. CATLIN. Corrective Action Plan Addendum for NC DOT Site #24-61. September 29, 2005.
44. CATLIN. Monitoring Report, May 2015 Sampling Event for NCDOT Site #24-61. October 22, 2015.
45. Brooks, Pierce, McLendon, Humphrey, and Leonard, Attorneys and Counsellors at Law. Chemical and Solvents, Inc. Facility. October 23, 1989.
46. U.S. Environmental Protection Agency. RCRA Info Search for Ecoflo, Inc. Date Accessed: February 25, 2019. Accessed on-line at:  
[https://ofmpub.epa.gov/rcrainfoquery\\_3.facility.information?pgm\\_sys\\_id=NCD980842132](https://ofmpub.epa.gov/rcrainfoquery_3.facility.information?pgm_sys_id=NCD980842132).
47. Arcadis. Indoor Air Sampling Results and Sub-Slab Depressurization Pilot Test Work Plan at Johnston Properties Building. June 17, 2011.
48. Cardinal Resources. Semiannual Groundwater Sampling Report and Site Update, Dow Corning Corporation. June 7, 2010.
49. CATLIN. Monitoring Report, May 2012 Sampling Event for NC DOT Site #24-61. July 27, 2012.
50. NCDENR. Groundwater Quality Standards, 15A NCAC 02L.0202. April 1, 2013.

51. URS Corporation. Semi-Annual Groundwater Monitoring Report – April 2014, Dow Corning Corporation. August 2014.
52. CATLIN. Monitoring Report, June 2014 Sampling Event for NC DOT Former Site #24-61. January 30, 2015.
53. URS Corporation. Semi-Annual Groundwater Monitoring Report – April 2015, Dow Corning Corporation. September 9, 2015.
54. S&ME. Soil Gas and Groundwater Assessment, Chemical and Solvents, Inc. Site. May 11, 2016.
55. EPA, Office of Solid Waste and Emergency Response (OSWER). OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air, OSWER Publication 9200.2-154. June 2015.
56. NCDENR, Division of Waste Management. Crawlspace Air Sampling Results – 2832 Camborne Street. July 15, 2016.
57. Arcadis. September 2016 Annual Groundwater and Semiannual Surface Water Sampling Report, Former Ashland Facility. February 7, 2017.
58. Tetra Tech. Removal Assessment Letter Report – Final, Patterson Street Solvent Plume. May 5, 2017.
59. Arcadis. Technical Memorandum. Subject: Groundwater Flow in Proximity to the MW-29 Well Cluster. June 23, 2016.
60. Tetra Tech. Removal Assessment Letter Report – Draft, Patterson Street Solvent Plume – Stage 2. April 13, 2018.
61. City of Greensboro. 2017 Annual Drinking Water Quality Report, Water System Number 02-41-010.
62. Cardinal Resources. RCRA Facility Assessment Report, Dow Corning Corporation, Revision 1. June 2007.
63. NCDENR, Division of Waste Management. Warning Letter, Hazardous Waste Storage at Ecoflo. April 2, 2013.
64. NCDENR, Division of Waste Management. Warning Letter, Hazardous Waste Storage and Processing by Ecoflo. January 17, 2007.
65. North Carolina Department of Conservation and Development, Division of Mineral Resources. Geology and Ground Water in the Greensboro Area, North Carolina. Bulletin 55. 1948.
66. U.S. Geological Survey (USGS). Statistical Analysis Relating Well Yield to Construction Practices and Siting of Wells in the Piedmont and Blue Ridge Provinces of North Carolina. Water-Supply Paper 2341-A. 1989.
67. USGS. The Hydrogeologic Framework and Reconnaissance of Groundwater Quality in the Piedmont Province of North Carolina. Water-Resources Investigations Report 88-4130. 1989.

68. URS Corporation. Site Characterization Report – Revision 1, Dow Corning Corporation. June 2014.
69. Arcadis. Comprehensive RCRA Facility Investigation Report – Phase III, Former Ashland Distribution Facility. September 2013.
70. U.S. Fish and Wildlife Service, National Wetlands Inventory. Patterson Street Solvent Plume Site, South Buffalo Creek Wetlands. Date Accessed: December 4, 2018.
71. Piedmont Triad Regional Water Authority. 2017 Annual Drinking Water Quality Report, PWSID# NC3076010.
72. U.S. Department of Commerce. Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years. Technical Paper No. 40. May 1961.
73. U.S. Department of Commerce. Mean Monthly and Annual Evaporation from Free Water Surface for the United States, Alaska, Hawaii, and West Indies. Technical Paper No. 13. July 1950.
74. Federal Emergency Management Agency. Flood Insurance Rate Map, Panel 7854. June 18, 2007.
75. USGS. Streamflow Measurements for South Buffalo Creek Near Greensboro, North Carolina. Date Accessed: January 10, 2019. Accessed on-line at: [https://waterdata.usgs.gov/nwis/measurements?site\\_no=02095000Sheet1agency\\_cd=USGSStreamflow](https://waterdata.usgs.gov/nwis/measurements?site_no=02095000Sheet1agency_cd=USGSStreamflow).
76. North Carolina Department of Health and Human Services. Inland Fishing Regulations & Information, Fish Consumption Advisories 2017 – 2018.
77. U.S. Fish and Wildlife Service. Endangered Species, Threatened Species, Federal Species of Concern, and Candidate Species, Guilford County, North Carolina. October 4, 2018.
78. Fishidy Interactive Map for Buffalo Creek. Date Accessed: December 21, 2018.
79. Guilford County Tax Assessors Office. Property Summary for Sampling Locations on Camborne Street. Date Accessed: January 10, 2019.
80. Tetra Tech. Project Note to File. Subject: Population within distance rings for Patterson Street Solvent Plume. December 17, 2018.
81. U.S. Census Bureau. Quickfacts for Guilford County, North Carolina. Date Accessed: December 4, 2018. Accessed on-line at: <https://www.census.gov/quickfacts/guilfordcountynorthcarolina>.

## **APPENDIX A**

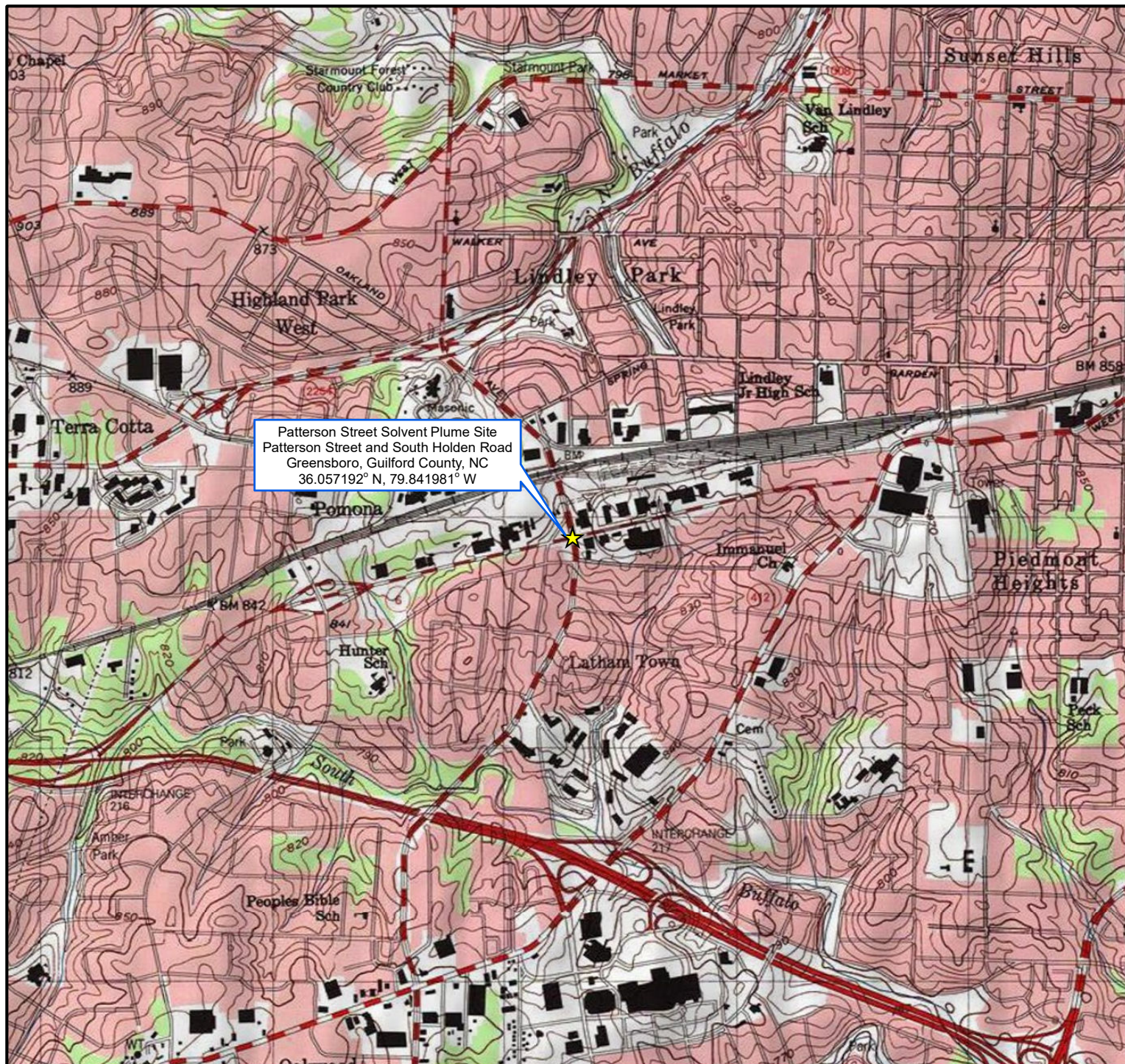
### **FIGURES**

(Two Pages)

#### FIGURE

- 1 SITE LOCATION
- 2 STUDY AREA





## Legend

★ Site Location



0 1,000 2,000  
Feet

Map Source:  
USGS 7.5 Minute Topographic Quadrangle Map:  
Greensboro, NC 1997.



United States  
Environmental Protection Agency  
Region 4

## FIGURE 1 Site Location

**TDD Name:** Patterson Street Solvent  
Plume Site

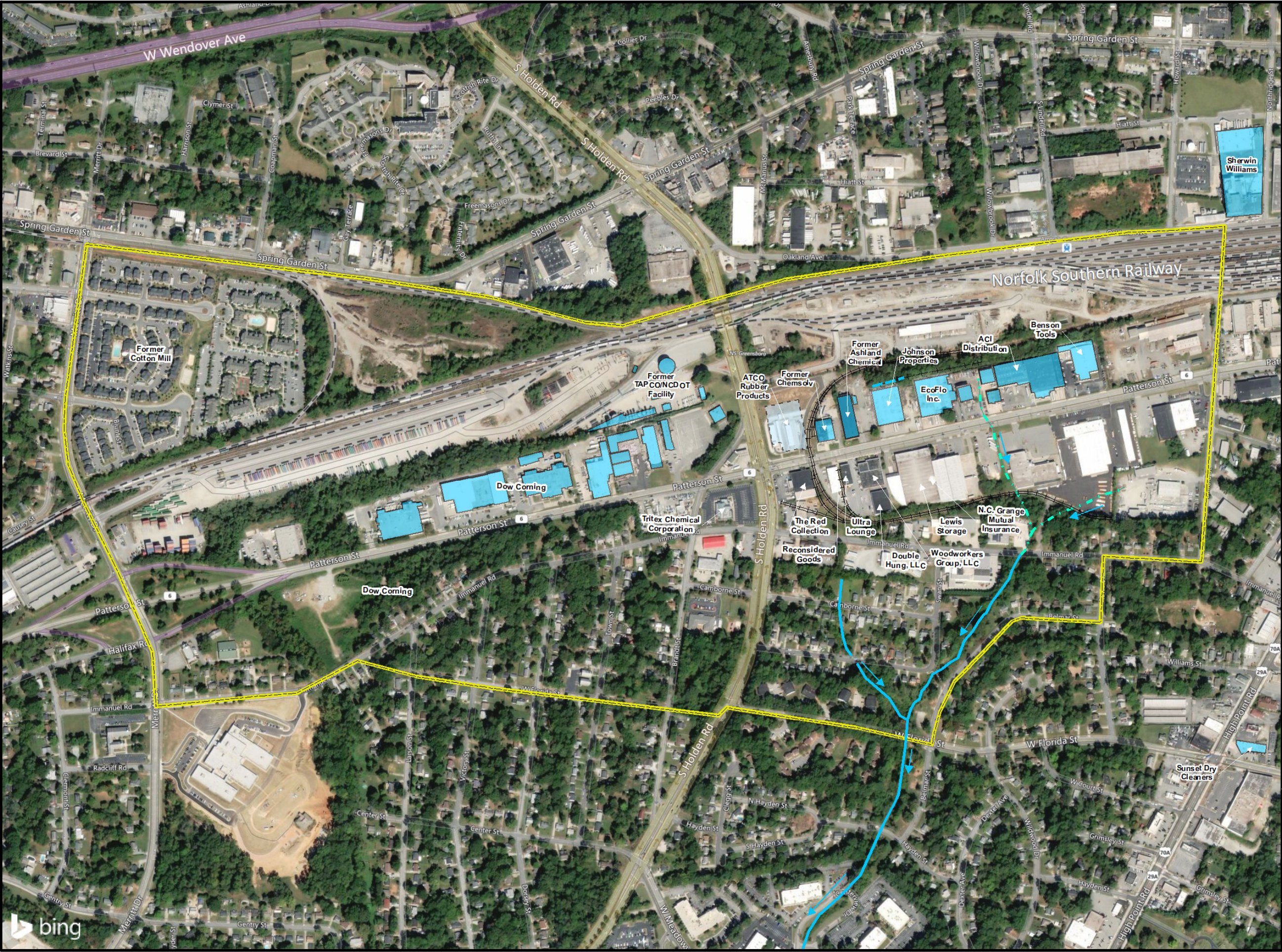
**TDD No.:** TT-05-041

**City:** Greensboro **County:** Guilford **State:** North Carolina

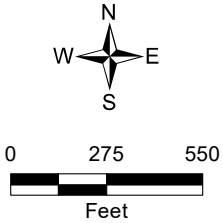


Date:  
1/15/2019  
Analyst:  
dale.vonbusch





- Legend**
- Drainage Ditch
  - Railroad Spur
  - Former Railroad Spur
  - Stream
  - Underground Stream
  - Direction of Flow
  - Approximate Study Area
  - Building
  - Former Building



Notes:  
NCDOT - North Carolina Department of Transportation  
TAPCO - Thompson Arthur Paving Company  
Map Source:  
Bing Maps Aerial Imagery, 2015.

United States  
Environmental Protection Agency  
Region 4

**FIGURE 2**  
Study Area

**TDD Name:** Patterson Street Solvent Plume Site  
**TDD No.:** TT-05-041  
**City:** Greensboro  
**County:** Guilford  
**State:** North Carolina

**TETRA TECH**  
**Date:** 3/29/2019  
**Analyst:** dale.vonbusch



**APPENDIX B**  
**CERCLA ELIGIBILITY FORM**  
(One Page)



# CERCLA ELIGIBILITY QUESTIONNAIRE

Site Name: Patterson Street Solvent Plume\*\*

City/County/State: Greensboro, Guilford County, North Carolina

EPA ID Number: NCN000404887

I.	CERCLA ELIGIBILITY	<u>Yes</u>	<u>No</u>
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Did the facility cease operations prior to November 19, 1980?

\_\_\_\_\_

If answer YES, STOP, facility is probably a CERCLA site.

If answer NO, Continue to Part II.

II.	RCRA ELIGIBILITY	<u>Yes</u>	<u>No</u>
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Did the facility file a RCRA Part A application?

\_\_\_\_\_

If YES:

1. Does the facility currently have interim status?

\_\_\_\_\_

2. Did the facility withdraw its Part A application?

\_\_\_\_\_

3. Is the facility a known or possible protective filer?  
(facility filed in error)

\_\_\_\_\_

4. Type of facility:

Generator X Transporter \_\_\_\_\_ Recycler \_\_\_\_\_

TSD (Treatment/Storage/Disposal) X

Does the facility have a RCRA operating or post closure permit?

\_\_\_\_\_

Is the facility a late (after 11/19/80) or non-filer that has been identified by the EPA or the State? (facility did not know it needed to file under RCRA)

\_\_\_\_\_

If all answers to questions in Part II are NO, STOP, the facility is a CERCLA eligible site.

If answer to #2 or #3 is YES, STOP, the facility is a CERCLA eligible site.

If answer #2 and #3 are NO and any OTHER answer is YES, site is RCRA, continue to Part III.

III.	RCRA SITES ELIGIBLE FOR NPL	<u>Yes</u>	<u>No</u>
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Has the facility owner filed for bankruptcy under federal or state laws?

\_\_\_\_\_

Has the facility lost RCRA authorization to operate or shown probable unwillingness to carry out corrective action?

\_\_\_\_\_

Is the facility a TSD that converted to a generator, transporter or recycler facility after November 19, 1980?

\_\_\_\_\_

\*\*The Patterson Street Solvent Plume site encompasses about 100 acres in Greensboro, Guilford County, North Carolina. Chlorinated solvents including DCE, PCE, and TCE, among others have been detected in soil, exterior and sub-slab soil gas, groundwater, surface water, and ambient and indoor air samples at industrial, commercial, and residential properties. These releases are co-mingled – specific releases cannot be separated and attributed to a specific source. Therefore, the site evaluated is a co-mingled groundwater plume.